Energy Access for Climate Change Mitigation and Adaptation: The 'Micro Renewable' Solution

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Abstract

Energy and its access have been the principal driving forces behind development. While energy access has accelerated development, the traditional paths of achieving it have created the crisis of climate change. This makes energy and its access the principal factors defining our response to climate change. Most parts of the world are seeing a rapid increase in population. Providing energy to this population will involve extensive use of fossil fuels leading to large quantity of green house gas (GHG) emissions, which will augment the crisis of climate change. Thus, the path that we chose for development will be highly critical for climate change mitigation. The countries and regions with higher poverty, lower levels of human development, and lesser energy access will have fewer options and lower adaptive capacity.[1] It has also been documented that countries with high level of per capita electricity consumption perform better both economically and socially. It can be inferred that access to energy plays a defining role in adaptation to climate change. Ironically, the historic path of attaining energy access through fossil fuel use augments the problem. However, renewable energy emerges as a solution that can help in providing wider energy access at the same time avoiding GHG emissions. The solution for loss of precious energy in long distance transmission and distribution can be found in micro renewable energy. Micro renewable energy can not only bring a balance between climate change mitigation and adaptation but also save energy otherwise lost in transmission and distribution.

Keywords: Microgeneration; Microenergy; Renewable energy; Mitigation; Adaptation

Introduction

Climate change has emerged as the single largest problem being faced by the world today. While the climate has always varied naturally, evidences now point towards a new kind of change which is largely attributed to anthropogenic activities. Man due to his indiscriminate use of fossil fuels, deforestation and land use change has emitted large quantities of green house gases (GHG) into the atmosphere. This has led to disturbance in the critical balance of atmosphere, the result being an increase in global temperatures and change in climatic patterns.

Fig 1 reveals that at 26%, energy supply accounts for the largest share of global green house gas (GHG) emissions.[2] Thus, making the energy sector sustainable is one of the keys to climate change mitigation.

It has now also been established that this changes in global climate will lead to severe impacts like sea level rise, change in cropping patterns, floods, droughts etc. As a whole climate change will have an overshadowing impact on people, economies and ecosystems.[3] Hence, now equal emphasis is being put on both on climate change mitigation and adaptation. Development and adaptation are closely linked. Development increases the resilience and adaptive capacities of the people. It has been documented that countries which possess a high level of per capita electricity consumption rank higher in both GDP per capita as well as HDI.[4]

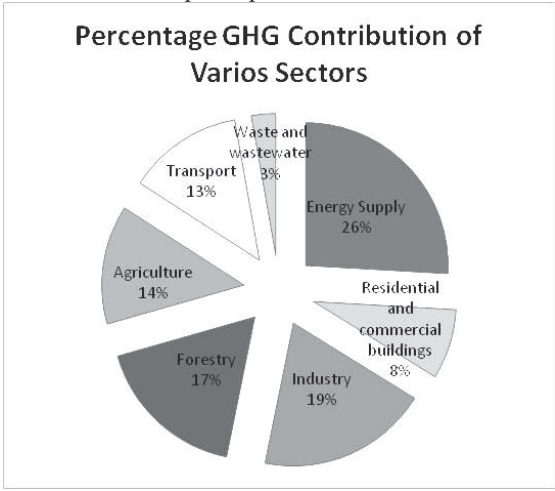

Figure 1: Percentage GHG contribution of various sectors (IPCC 2007)

Hence, it can be said that energy and its access form a nexus between climate change mitigation and adaptation. Energy and the pathways to its access can work both ways to implement our agenda of climate

[1] CCCD (2009). Energy Access, Climate and Development, Stockholm: Commission on Climate Change and Development

[2] IPCC (2007). Technical Summary: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Inter Governmental Panel on Climate Change Secretariat, Cambridge, U.K: Cambridge University Press IPCC (2001). Climate change 2001: synthesis report, Intergovernmental Panel on Climate Change Secretariat, Cambridge, UK: Cambridge University Press

3 UNFCCC (2005). Caring for climate 2005 - A guide to the Climate Change Convention and the Kyoto Protocol, Bonn: United Nations Convention on Climate Change

4 Kanagawa, M., & Nakata, T. (2008). Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries, Energy Policy, 36, 2016–2029

change mitigation and adaptation. Novel solutions which can bring a balance between mitigation and adaptation need to be found and evaluated. 'Micro renewable energy' (MRE) could be one such solution.

Electricity generation by individual households (known as microgeneration) is attracting an increasing amount of interest within the government, industry and the research community.[5] Microgeneration can also be understood as generation of energy at a very small scale in decentralised manner. The terms microgeneration or microenergy can be alternatively used. Also, the already widely used term, decentralised energy can be modified into micro decentralised energy (MDE) and be alternated with microgeneration. The term micro renewables or micro renewable energy (MRE) emerges from the use of renewable energy in microgeneration or micro decentralised energy.

Research Objectives

As discussed above, energy and its access are the principal factors defining our response to climate change. Although energy efficiency also figures prominently in all plans concerning climate change mitigation, it may not be as relevant from the point of view of climate change adaptation. This paper begins with a hypothesis that 'micro renewables' or 'microgeneration through renewable energy' can fashion the critical balance between climate change mitigation and adaptation by providing clean energy access. The critical research questions being looked at here are:

- Can micro renewable energy help in climate change mitigation?
- Does micro renewable energy promote the cause of climate change adaptation?
- Can this new form of energy foster a balance between the domains of mitigation and adaptation?

The objective of this paper is to ponder upon these critical questions and rationalise this hypothesis to evolve it into a theory.

Methods

To prove the hypothesis, various sources related to the fields of renewable energy, energy access, microenergy, Millennium Development Goals (MDGs), climate change mitigation and adaptation were studied. The case of UK was studied, where microgeneration is being developed as a possible solution to energy sustenance and climate change mitigation. Also, India was studied as a country where micro generation could provide solutions for wider energy access and climate change adaptation. The study resulted in the arguments presented in the paper, strengthening of the hypothesis and ultimately emergence of a theory. While a study of the relevance of micro renewable sources cannot be complete without an all round view from the perspectives of technology, socio-economic and policy, the present study has been limited to the policy perspective.

Discussions

Energy and Development

Energy and its access have always been the most prominent factors driving development. Energy has helped in reducing poverty, improving life expectancy, providing livelihood opportunities and improving the overall standard of living. No country in modern times has substantially reduced poverty without a massive increase in its use of commercial energy and/or a shift to more efficient energy sources that provide higher quality energy services.[6] Energy services are highly correlated with several key indicators of human development such as infant mortality, illiteracy, life expectancy and fertility as well as the composite Human Development Index. The relationship between energy and development is best illustrated by the fact that the population living below the poverty line in developing countries reduces as we move from a low level of electrification to higher levels.[7]

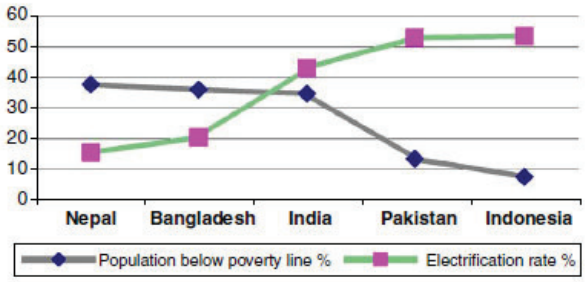

Figure 2: Electrification vis-a-vis population below poverty line (Srivastava and Rehman 2005)

The importance of energy for development was also recognised by the Convention on Sustainable Development (CSD) at its ninth session in 2001, when it said that poverty reduction goals, expressed by the Millennium Assembly of the United Nations in 2002, would not be met without increased access to modern energy by the world's poor[8]

The World Summit on Sustainable Development's (WSSD) Plan of Implementation in its poverty eradication chapter urges ''actions and efforts… at all levels to improve access to reliable and affordable energy services for sustainable development sufficient to facilitate the achievement of the Millennium Development Goals, including the goal of halving the

[5] Watson, J. (2004). Co-provision in sustainable energy systems: The case of microgeneration. Energy Policy, 32, 1981–1990

[6] UNDP (2005). Energizing the millennium developing goals: A guide to energy's role in reducing poverty, United Nations Development Programme, New York

[7] Srivastava, L., & Rehman, I. H. (2005). Energy for sustainable development in India: Linkages and strategic direction. Energy Policy, 34, 643–654

[8] GFSE (2002). Summary of the Third Meeting of the Global Forum on Sustainable Energy: Public-Private Partnerships for Rural Energy Development 27–29 November 2002 Sustainable Developments, 78(1), 1–9

proportion of people in poverty by 2015, and as a means to generate other important services that mitigate poverty, bearing in mind that access to energy facilitates the eradication of poverty''

It must also be recognised that while sufficient access to energy has been limited to some parts of the world, the pathway for access of energy is affecting all parts of the world.

Energy and Climate Change Adaptation

Climate change will lead to problems like crop failure, increase in the frequency and intensity of natural disasters, and increase in the spread of disease[9] thus overall reducing standard of living. This will be more pronounced in some parts of the world than in others.

It is understood that the more exposed a system is to a particular climate stimulus, the greater the system vulnerability; conversely, the greater the adaptive capacity of the system to a given climate event, the lower its vulnerability.[10] A relation between development and adaptive capacity has also been established. IPCC observed that, ''the ability to adapt clearly depends on the state of development… underdevelopment fundamentally constrains adaptive capacity, especially because of a lack of resources to hedge against extreme but expected events.''[11] [12] Enhancing adaptive capacity, ''involves similar requirements as promotion of sustainable development'' such as resource access, poverty reduction, increased equity and increased capability to participate in local politics and actions.[13] Hence, a nexus between energy development and climate change adaptation emerges with energy access reinforcing development and development reinforcing adaptation.

This nexus also tells us that the parts of the world with the least access will be the worst affected by the impacts of climate change as they lack resilience owing to their lack of development stemming from the lack of access to energy. These countries and regions with higher poverty, lower levels of human development, and lesser energy access will have fewer options and lower adaptive capacity.[14] This is an evidence of the fact that for adaptation to the problem of climate change, it is critical that we increase the resilience of these parts of the world by promoting development through improved access to energy.

As evident from fig 3, there is a huge discrepancy in the energy consumption levels between the developed and the developing countries as more than two billion people in the world (largely in Latin America, Asia, and Africa) have no access to modern energy supplies.

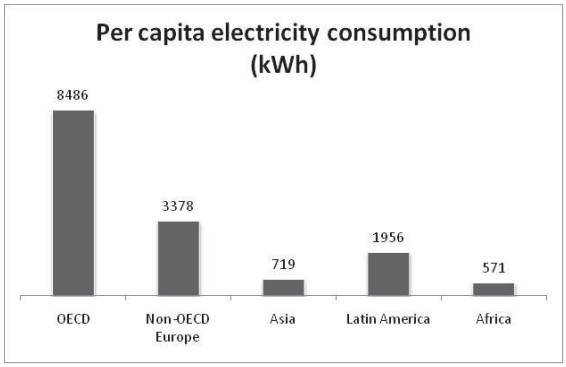

Figure 3: Energy consumption in developed and developing countries (IEA 2010)

Due to the vital link between energy and development, lack of energy not only has a negative bearing on the livelihoods of people, but also on several other drivers of sustainable development including water, agriculture, and health. This negative impact on such vital elements will have a decisive effect on the resilience of these people. This reiterates the significance of energy access for climate change adaptation.

Energy and Climate Change Mitigation

Today most of our energy production is fossil fuel based and centralised. A need for rapid development has led to the establishment of large fossil fuel based power plants supplying power to a land area thousands of kilometres in size. The development of these energy systems has surely helped accelerate development in certain parts of the world. At the same time emissions from large scale, indiscriminate use of fossil fuels in these power plants has led to problems of climate change. Hence, it can be said that Climate Change is a derivative problem of development.

[9] IPCC (2001). Adaptation to climate change in the context of sustainable development and equity. In: Smit B, Pilifosova O (eds.), Climate change 2001: impacts, adaptation and vulnerability, contribution of working group II to the third assessment report of the intergovernmental panel on climate change, Intergovernmental Panel on Climate Change Secretariat, Cambridge, UK: Cambridge University Press

10 Smit, B., & Pilifosova O. (2003). From adaptation to adaptive capacity and vulnerability reduction. In: Smith J., Klein R., Huq S. (eds.), Climate change, adaptive capacity, and development. London: Imperial College Press

[11] IPCC (2001). Adaptation to climate change in the context of sustainable development and equity. In: Smit B, Pilifosova O (eds.), Climate change 2001: impacts, adaptation and vulnerability, contribution of working group II to the third assessment report of the intergovernmental panel on climate change, Intergovernmental Panel on Climate Change Secretariat, Cambridge, UK: Cambridge University Press

[12] Ribot, J. C, Najam, A., & Watson, G. (1996). Climate variation, vulnerability and sustainable development in the semi-arid tropics. In: Ribot J. C., Magalhaes A. R., Panagides S. S, (eds.), Climate variability, climate change and social vulnerability in the semi-arid tropics. Cambridge: Cambridge University Press

13 IPCC (2001). Adaptation to climate change in the context of sustainable development and equity. In: Smit B, Pilifosova O (eds.), Climate change 2001: impacts, adaptation and vulnerability, contribution of working group II to the third assessment report of the intergovernmental panel on climate change, Intergovernmental Panel on Climate Change Secretariat, Cambridge, UK: Cambridge University Press

14 CCCD (2009). Energy Access, Climate and Development, Stockholm: Commission on Climate Change and Development

Energy supply sector is the single largest contributor to global green house gas emissions (fig 1). High energy-demand growth rates in Asia (3.2% per year 1990–2004) are projected to continue and to be met mainly by fossil fuels (*high agreement, much evidence*). In 2004, globally emissions from power generation and heat supply alone were 12.7 GtCO2-eq (26% of total emissions) including 2.2 GtCO2eq from CH4. In 2030, according to the World Energy Outlook 2006 baseline, these will have increased to 17.7 GtCO2-eq. *(high agreement, much evidence)*.[15]

Hence we can conclude that reduction in GHG emissions in the energy sector can go a long way in mitigating climate change.

The 'Micro Renewable' Solution

As discussed in the paper, energy and its access are critical elements for climate change adaptation. Ironically, following the historical path of development and attaining energy access is not only the driver of climate change but also the key to adapt to climate change. To escape this paradox and engender development through increased energy access while avoiding increased GHG emissions, the shift of energy dependence from fossil fuels to renewable energy sources must be achieved. This can be an ideal solution for a country like India which needs to provide energy solution to more than 50% of its population (Urmee et al 2008), still lacking energy access.

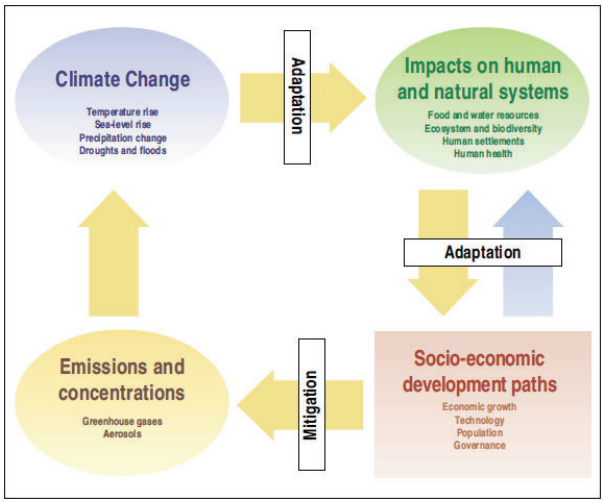

Figure 4: Integrated assessment framework for considering anthropogenic climate change (IPCC 2001)

It can be observed from the bottom right box in fig 4 that by selection of correct socio-economic development paths both climate change mitigation and adaptation can be reinforced. The socio-economic development paths point towards pathways for economic growth and technology among other things. Thus right technology choices for energy access and economic growth will be the imperative for both climate change mitigation and adaptation.

Renewable energy sources like wind, solar, and biomass can be fashioned and used in a decentralised manner, avoiding the transmission and distribution losses of precious energy. While increasing use of renewable energy will help in avoidance of GHG emissions, their deployment in decentralised manner will save precious energy otherwise lost in transmission and distribution. According to figure 5, the world average for transmission and distribution losses in the year 2007 have been estimated to stand at 8.4% of the total electricity output. This figure rises to a staggering 24.7% for a developing country like India for the same year. This energy currently being wasted, if conserved can cater to many more people currently living in energy poverty.MRE will not only avoid GHG emissions but also provide energy access to the population at large. Thus, sustainable development can be achieved by balancing climate change mitigation and adaption.

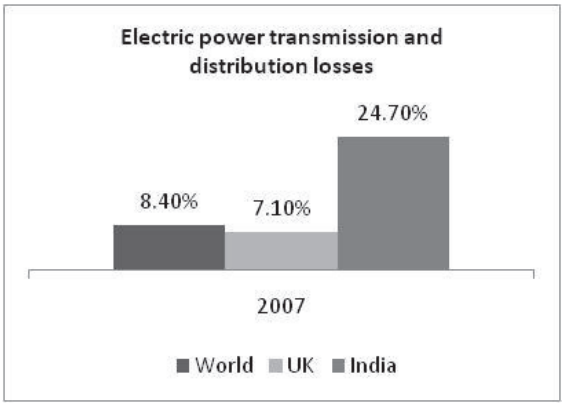

Figure 5: Electric power transmission and distribution losses (% of output) (World Bank Data Bank)

United Kingdom (UK) has been one of the leaders in the field of microgeneration and can be studied as a case for better understanding of the microgeneration scenario. UK has defined microgeneration as ''the small-scale production of heat and/or electricity from a low carbon source''. It has further been defined as anything below 50-100 kW, with most household electricity-supply installations being below 3 kWe; slightly larger for heat-supply.

UK has set a target of 80% reduction in its emissions by 2050 with base year as 1990 (Climate change act 2008). Also, UK has committed itself to the shorter term plan of EU, 20-20-20 which mandates a 20% reduction in green house gas emissions (below 1990 levels) and sourcing 20% energy from renewables by 2020. These are ambitious targets and microenergy is set to play a big role in achieving this target. Microgeration until now does not has a substantial share in the UK's energy mix but it is being projected that it

[15] IPCC (2007). Technical Summary: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Inter Governmental Panel on Climate Change Secretariat, Cambridge, U.K: Cambridge University Press IPCC (2001). Climate change 2001: synthesis report, Intergovernmental Panel on Climate Change Secretariat, Cambridge, UK: Cambridge University Press

could contribute to as much as 10% by 2020.[16] According to the energy saving trust, microgeneration could supply 30-40% of UK electricity demand by 2050.[17]

It has also been projected that by 2050 microgeneration could help reduce household carbon emissions in UK by 15%.[18] Within UK, several examples have already been set in the field of distributed energy systems. Woking Borough Council achieved a 49% reduction in energy consumption and a 77% reduction in CO2 emissions between 1991 and 2004.[19]

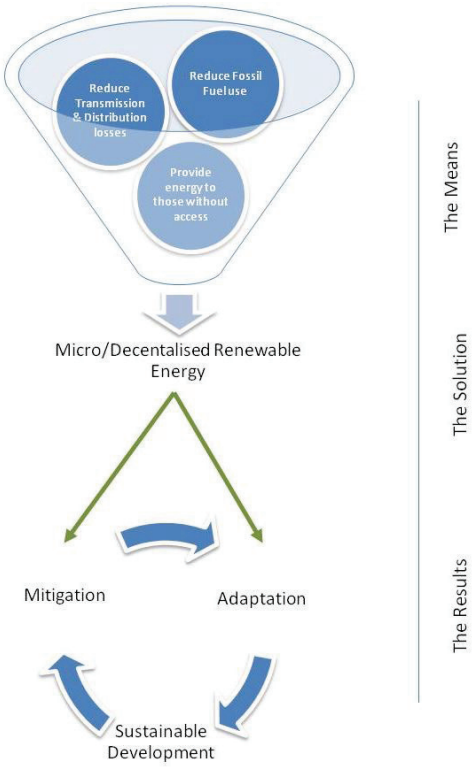

Figure 6: The 'micro renewable' solution for Climate Change Mitigation and Adaptation

India, like most developing countries is trying to make energy accessible to much of its wide spread rural population. Partial success has been achieved but still a huge gap needs to be covered for the country to become energy independent and make much of its population more climate resilient. However, for this to happen some of the current approaches need to be revisited and new paths need to be discovered.

Energy provision in the rural areas of India has become synonymous with extension of the centralised grid to the villages. Hence, if the grid reaches the village, its energy needs are taken to have been met irrespective of the power or the lack of it in the grid. Though in India, 86.76% villages have been electrified[20] only 43.5% of rural households have access to electricity. The centralized grid-based rural electrification programme has been expensive, and due to social considerations, has become a huge financial burden on the electric utilities.[21] In such a scenario microgeneration through renewable energy sources could be an effective tool to, on the one hand increase the percentage of households electrified and on the other hand reduce financial burden on the electric utilities.

If we look at the Millennium Development Goals (figure 7), we can say that high quality energy services (not necessarily MRE) are positively associated with development goals. However, as we look at Goal 7 (ensuring environmental sustainability), we can say with some certainty that 'distributed renewable energy' or 'micro renwables' are the only realistic option. The alternative 'business-as-usual' option is extending national power grids and expanding centralized power generation capacity using fossil fuels. This business as usual scenario is not compatible with stabilized atmospheric CO_2 concentrations and risks catastrophic climate change (Nakicenovic et al. 1998). Keeping the immediate need of providing energy services and ensuring sustainability in mind one can say that MREs might be the only realistic option. The majority of the world's population specifically in the developing nations is still rural, geographically dispersed, and generally well-matched to the diffused nature of renewable energy resources.[22]

16 Mott MacDonald (2004). System Integration of Additional Micro-generation, DTI

17 Energy Saving Trust (2005). Potential for Micro-generation, Study and Analysis, Energy Saving Trust

18 ibidem

19 Allen. S. R., Hammond, G. P., & McManus M. C. (2007). Prospects for and barriers to domestic micro generation: A United Kingdom perspective. Applied Energy, 85, 528–544

20 Government of India (2001). Planning Commission. Annual report on the working of state electricity boards & electricity departments. New Delhi: Government of India, Planning Commission

21 Rehman, I.H., & Bhandari, P., (2002). Rural energy policy and planning: issues and perspective. In: Conference on Rural Energy Transition organized by Centre for Environmental Science and Policy (Stanford) and The Energy and Resources Institute (TERI), 5–7 November 2002, New Delhi.

22 WEC/FAO (1999). The challenge of rural energy poverty in developing countries, London: World Energy Council and Food and Agriculture Organization of the United Nations

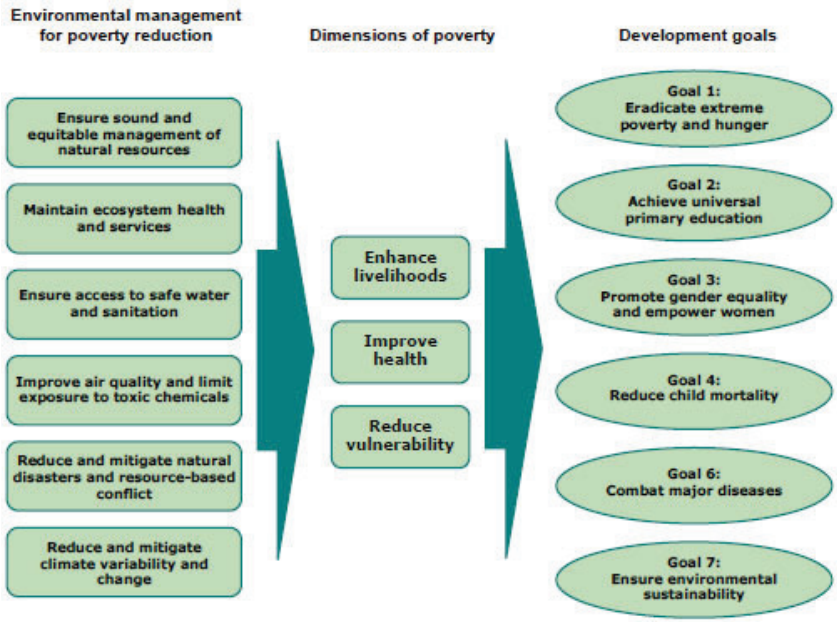

Figure 5: Environment and MDGs (World Bank 2002)

Table 1: Micro renewable energy (MRE) as a solution for mitigation and adaptation

Energy and mitigation or adaptation	MRE
Energy sector is the largest contributor to global emissions (Mitigation)	MRE is by definition non fossil fuel source with no permanent GHG emissions
Energy access needs to be provided to a large part of the global population specially in developing countries which are mostly rural in nature and dispersed far and wide (like in India) (Adaptation)	MRE is decentralised in nature and can be ideal for the dispersed rural population
Saving energy lost in transmission and distribution (mitigation)	MRE works at local level and excludes the need to long distance transmission and distribution thus saving precious energy

Concluding our discussion we can say that in case of the energy sector 'micro renewables' or micro generation from renewable energy can fit the slot reserved for the pivot which can run the wheels of climate change mitigation and adaptation together. Although a harmony between mitigation and adaptation cannot be considered as the panacea but it is one of the most important requisites and MRE can help achieve it. Considering the justifications presented above we can finish by saying that our hypothesis has been converted into a theory that 'micro renewables' or 'microgeneration through renewable energy' can fashion the critical balance between climate change mitigation and adaptation by providing clean energy access.